

CLAIMS

1. A face detection apparatus for tracking a detected face between images in a video sequence, the apparatus comprising:

- 5        a first face detector for detecting the presence of face(s) in the images;  
          a second face detector for detecting the presence of face(s) in the images;  
          the first face detector having a higher detection threshold than the second face detector, so that the second face detector is more likely to detect a face in a region in which the first face detector has not detected a face; and

10      a face position predictor for predicting a face position in a next image in a test order of the video sequence on the basis of a detected face position in one or more previous images in the test order of the video sequence;

in which:

15      if the first face detector detects a face within a predetermined threshold image distance of the predicted face position, the face position predictor uses the detected position to produce a next position prediction;

if the first face detector fails to detect a face within a predetermined threshold image distance of the predicted face position, the face position predictor uses a face position detected by the second face detector to produce a next position prediction.

- 20      2. Apparatus according to claim 1, in which the first face detector is operable:  
          to derive a set of attributes from regions of each successive image;  
          to compare the derived attributes with attributes indicative of the presence of a face;  
          to derive a probability of the presence of a face by a similarity between the derived attributes and the attributes indicative of the presence of a face; and  
          to compare the probability with a threshold probability.

25      3. Apparatus according to claim 2, in which the attributes comprise the projections of image areas onto one or more image eigenvectors.

- 30      4. Apparatus according to any one of the preceding claims, in which the second face detector is operable to compare the colours of image regions with colours associated with human skin.

5. Apparatus according to claim 4, the apparatus being operable to discard a face track if the second detector detects that the detected face differs by more than a threshold amount from a skin colour.

5 6. Apparatus according to any one of the preceding claims, in which the face position predictor is initiated only in response to a face detection by the first face detector.

10 7. Apparatus according to any one of the preceding claims, in which if the first and second face detectors both fail to detect a face within a predetermined threshold image distance of the predicted face position, the face position predictor uses the predicted face position to produce a next position prediction.

15 8. Apparatus according to claim 7, in which the apparatus is arranged to discard a face tracking detection if, for more than a predetermined proportion of images, the face position predictor uses the predicted face position to produce a next position prediction.

20 9. Apparatus according to any one of the preceding claims, in which the apparatus is arranged to discard a face tracking detection if, for more than a predetermined proportion of images, the face position predictor uses a face position detected by the second face detector to produce a next position prediction.

10. Apparatus according to any one of the preceding claims, in which if two faces are being tracked in respect of an image, one track is discarded so that:

25 a track based on a detection by the first detector has priority over a track based on a detection by the second detector or a predicted position; and

a track based on a detection by the second detector has priority over a track based on a predicted position.

30 11. Apparatus according to claim 10, in which if two faces are being tracked in respect of an image by means of the same detector, one track is discarded so that the track with the larger detected face is maintained.

12. Apparatus according to any one of the preceding claims, in which at least two consecutive face detections by the first detector are required to start a face track.

13. Apparatus according to any one of the preceding claims, in which at least g face detections by the first detector are required every n frames (where  $g < n$ ) to maintain a face track.

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14. Apparatus according to any one of the preceding claims, the apparatus being operable to discard a face track if the detected face has an inter-pixel variance lower than a first threshold amount or higher than a second threshold amount.

10 15. Video conferencing apparatus comprising apparatus according to any one of the preceding claims.

16. Surveillance apparatus comprising apparatus according to any one of claims 1 to 14.

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17. A method of tracking a detected face between images in a video sequence, the method comprising the steps of:

using a first face detector to detect the presence of face(s) in the images;

using a second face detector to detect the presence of face(s) in the images;

20 the first face detector having a higher detection threshold than the second face detector, so that the second face detector is more likely to detect a face in a region in which the first face detector has not detected a face; and

predicting a face position in a next image in a test order of the video sequence on the basis of a detected face position in one or more previous images in the test order of the video 25 sequence;

in which:

if the first face detector detects a face within a predetermined threshold image distance of the predicted face position, the face position predicting step uses the detected position to produce a next position prediction; and

30 if the first face detector fails to detect a face within a predetermined threshold image distance of the predicted face position, the face position predicting step uses a face position detected by the second face detector to produce a next position prediction.

18. Computer software having program code for carrying out a method according to claim 17.

19. A providing medium for providing program code according to claim 18.

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20. A medium according to claim 19, the medium being a storage medium.

21. A medium according to claim 20, the medium being a transmission medium.

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